$$\Delta f = f_s = 1/t_s$$

(a)

(b)

Figure 1. The OFDM signals. (a) frequency domain representation of the OFDM sub-carriers. (b) The time domain signal with the added guard-period containing the cyclic prefix.
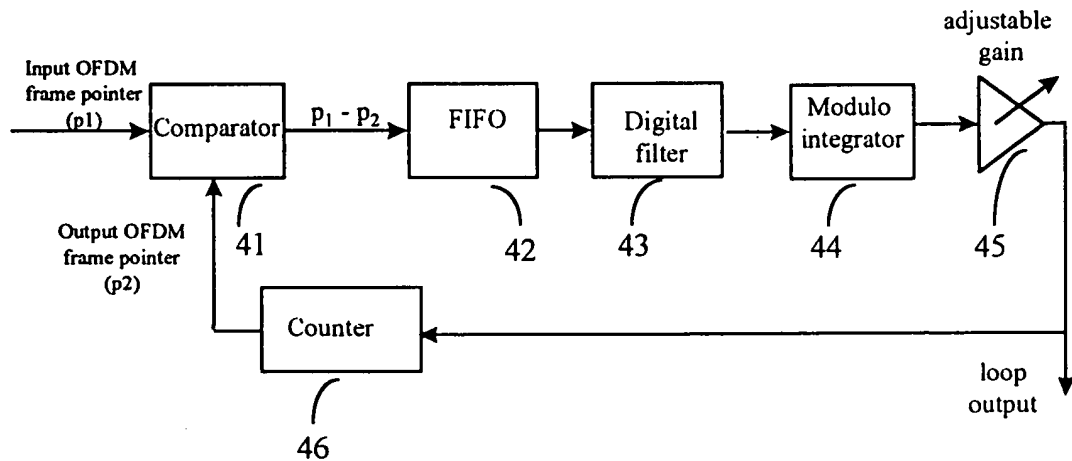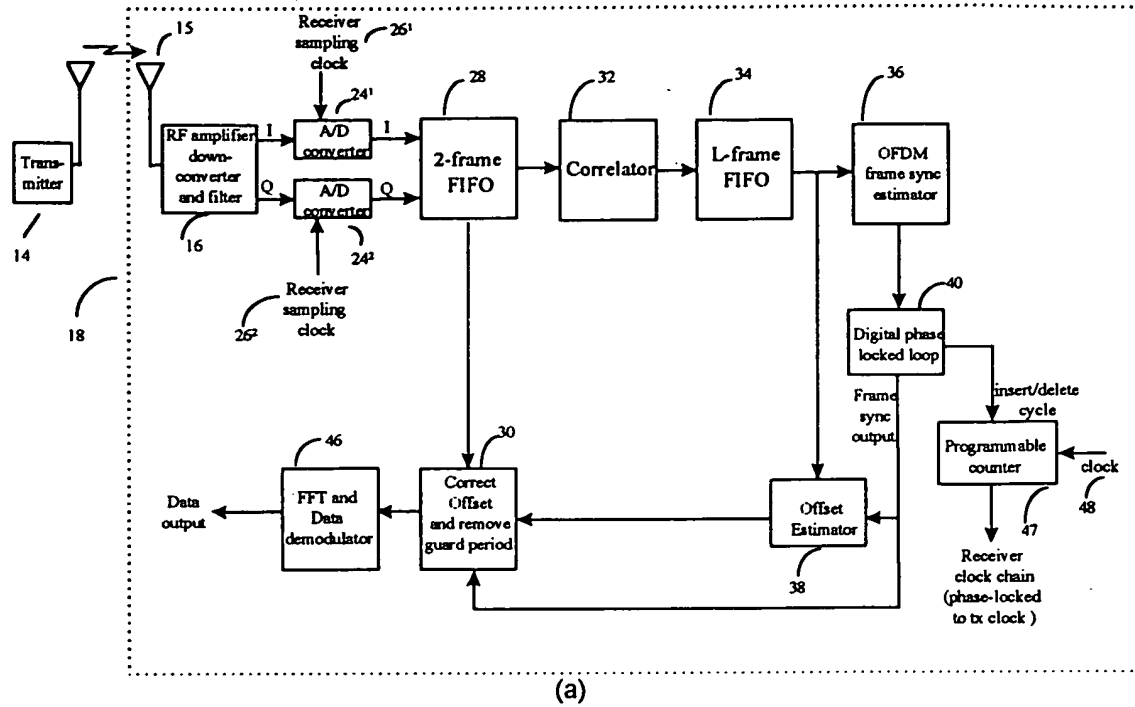
(a)

(b)

Figure 2. Offset correction procedure. (a) Functional block diagram of the algorithm. (b) Block diagram of the phase-locked loop.
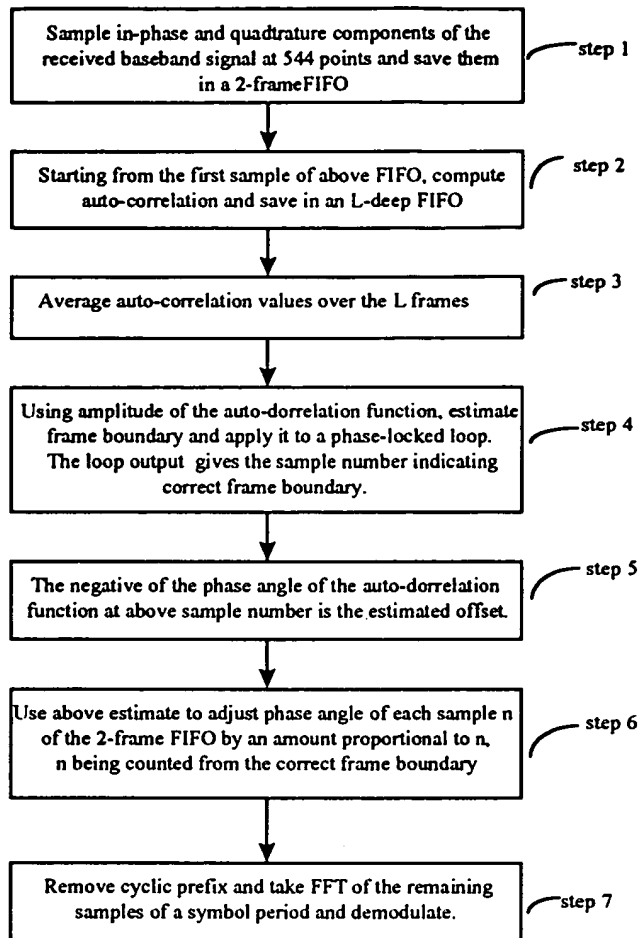
```
┌─────────────────────────────────────────┐
│ Sample in-phase and quadrature components │
│ of the received baseband signal at 544    │──── step 1
│ points and save them in a 2-frameFIFO     │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│ Starting from the first sample of above   │──── step 2
│ FIFO, compute auto-correlation and save   │
│ in an L-deep FIFO                          │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│ Average auto-correlation values over the  │──── step 3
│ L frames                                   │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│ Using amplitude of the auto-dorrelation   │
│ function, estimate frame boundary and     │──── step 4
│ apply it to a phase-locked loop.          │
│ The loop output gives the sample number   │
│ indicating correct frame boundary.        │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│ The negative of the phase angle of the    │──── step 5
│ auto-dorrelation function at above sample  │
│ number is the estimated offset.           │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│ Use above estimate to adjust phase angle  │
│ of each sample n of the 2-frame FIFO by   │──── step 6
│ an amount proportional to n,              │
│ n being counted from the correct frame    │
│ boundary                                   │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│ Remove cyclic prefix and take FFT of the  │──── step 7
│ remaining samples of a symbol period and   │
│ demodulate.                                │
└─────────────────────────────────────────┘
```

Figure 3. Summary of the algorithm.

test conditions	Noise	Offset	Fading	Offset correction	Bit Error Rate
1	No	0.30	No	No	0.1
2	No	0.5	No	No	0.35
3	10 dB SNR	No	No	-	0.000020
4	,,	0.5	No	Yes	0.000020
5	,,	No	Urban slow	-	0.01673
6	,,	No	Urban Fast	-	0.01325
7	,,	No	Rural	-	0.04763
8	,,	0.30	Urban slow	No	0.15000
9	,,	0.30	Urban slow	Yes	0.01500
10	,,	0.30	Urban fast	Yes	0.01022
11	,,	0.30	Rural	Yes	0.03727

Figure 4. BER performance under different test conditions.